

PATENT
Atty. Dkt. No. APPM/007669.P2/PPC/ECP/CKIM
Serial No.: 10/816,044

IN THE CLAIMS:

Please amend claims 1, 3, 17, 22, and 25, and replace the claims as follows:

1. (Currently Amended) A method for plating metal onto a substrate, comprising:
positioning the substrate in a catholyte solution contained in a catholyte chamber of a plating cell, the catholyte solution comprising:
an acid source at a concentration of between about 5 g/L and about 15 g/L;
a copper source at a concentration of between about 0.8M and about 0.9M;
chlorine ions at a concentration of between about 25 ppm ~~and about~~ and about 75 ppm; and
one or more additives; and
applying a plating bias between the substrate and an anode positioned in an anolyte chamber of the plating cell, the anolyte chamber being separated from the catholyte chamber by an ionic membrane and being supplied with an anolyte solution comprising a copper source having a concentration of greater than about 51 g/L, wherein the anolyte solution does not contain the one or more additives.
2. (Previously Presented) The method of claim 1, wherein the one or more additives in the catholyte solution comprises:
a leveler at a concentration of between about 2 mL/L and about 3 mL/L;
a suppressor at a concentration of between about 2 mL/L and about 3 mL/L;
and
an accelerator at a concentration of between about 5.5 mL/L and about 8 mL/L.
3. (Currently Amended) The method of claim 2, wherein the suppressor comprises a compound selected from the group consisting of ethylene oxide, propylene oxide, and combinations thereof.

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4. (Original) The method of claim 2, wherein the accelerator comprises sulfo propyldisulfide.
5. (Original) The method of claim 1, wherein the anolyte has a pH of between about 2 and about 4.8.
6. (Original) The method of claim 5, wherein the anolyte comprises a copper II salt having a concentration of copper ions of between about 0.1M and about 2M.
7. (Previously Presented) The method of claim 6, wherein the copper II salt comprises a compound selected from the group consisting of copper sulfate, copper sulfonate, copper chloride, copper nitrate, and blends thereof.
8. (Original) The method of claim 5, wherein the anolyte provides a copper transport of copper ions through the ionic membrane of between about 90% and about 100%.
9. (Previously Presented) The method of claim 1, wherein the anode is selected from the group consisting of a copper anode, a platinum anode, and combinations thereof.
10. (Previously Presented) A method for plating copper into features formed on a semiconductor substrate, comprising:
 - positioning the substrate in a plating cell, wherein the plating cell comprises:
 - a catholyte volume containing a catholyte solution;
 - an anolyte volume containing an anolyte solution, wherein the difference between the catholyte solution and the anolyte solution is that the catholyte solution comprises one or more additives;
 - an ionic membrane positioned to separate the anolyte volume from the catholyte volume; and

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an anode positioned in the anolyte volume;
applying a plating bias between the anode and the substrate;
plating copper ions onto the substrate from the catholyte solution; and
replenishing the copper ions plated onto the substrate from the catholyte solution with copper ions transported from the anolyte solution via the ionic membrane, wherein the anolyte solution has a copper concentration of greater than about 51 g/L.

11. (Original) The method of claim 10, wherein the copper concentration is supplied by copper sulfate pentahydrate having a molarity of between about 0.8M and about 0.9M.

12. (Previously Presented) The method of claim 11, wherein the anolyte solution has a pH of between about 2 and 4.8.

13. (Original) The method of claim 10, wherein the plating cell further comprises a diffusion member positioned between an upper surface of the ionic membrane and the substrate.

14. (Original) The method of claim 13, wherein the diffusion member comprises a porous ceramic disk.

15. (Original) The method of claim 10, wherein the ionic membrane comprises a membrane having a fluorized polymer matrix.

16. (Original) The method of claim 10, wherein the ionic membrane comprises a membrane having a polydivinylbenzol matrix.

17. (Currently Amended) The method of claim 12, wherein the catholyte solution comprises:

acid at a concentration of between about 5 g/L and about 15 g/L;
copper at a concentration of between about 0.8M and about 0.9M; and

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chlorine ions at a concentration of between about 25 ppm and about 75 ppm.

18. (Previously Presented) The method of claim 17, wherein the one or more additives in the catholyte solution further comprises:

a leveler at a concentration of between about 2 mL/L and about 3 mL/L;

a suppressor at a concentration of between about 2 mL/L and about 3 mL/L;

and

an accelerator at a concentration of between about 5 mL/L and about 8 mL/L.

19. (Previously Presented) A method for electrochemically plating copper onto features of a semiconductor substrate, comprising:

positioning the substrate in a plating cell having a catholyte solution volume, an anolyte solution volume, and an ionic membrane separating catholyte solution volume from the anolyte solution volume;

contacting the substrate with a catholyte solution;

applying an electrical bias between the substrate and an anode positioned in the anolyte volume, the electrical bias being sufficient to plate copper ions from the catholyte solution onto the substrate; and

replenishing copper ions plated from the catholyte solution via transfer of copper ions from an anolyte solution through the ionic membrane to the catholyte solution, the anolyte solution having a pH of between about 2 and about 4.8 and a copper ion concentration of between about 0.1M and about 2M, wherein the difference between the catholyte solution and the anolyte solution is that the catholyte solution comprises one or more additives.

20. (Original) The method of claim 19, wherein the copper ion concentration in the anolyte comprises between about 51 g/L and about 60 g/L of copper metal to the anolyte.

21. (Original) The method of claim 19, wherein the anolyte provides a copper

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transport of copper ions through the ionic membrane of between about 90% and about 100%.

22. (Currently Amended) The method of claim 19, wherein the catholyte solution volume comprises:

an acid source at a concentration of between about 5 g/L and about 15 g/L;

a copper source at a concentration of between about 0.8M and about 0.9M; and

chlorine ions at a concentration of between about 25 ppm and about 75 ppm.

23. (Previously Presented) The method of claim 22, wherein the one or more additives in the catholyte further comprises:

a leveler at a concentration of between about 2 mL/L and about 4 mL/L;

a suppressor at a concentration of between about 1.5 mL/L and about 3 mL/L;

and

an accelerator at a concentration of between about 5.5 mL/L and about 8 mL/L.

24. (Previously Presented) The method of claim 23, wherein the anode is selected from the group consisting of a copper anode, a platinum anode, and combinations thereof.

25. (Currently Amended) A method for plating copper onto a substrate, comprising:

positioning the substrate in a catholyte plating solution contained in a catholyte chamber of a plating cell, the catholyte plating solution comprising:

an acid source at a concentration of between about 5 g/L and about 15 g/L;

a copper source at a concentration of between about 0.5M and about 1.0M;

chlorine ions at a concentration of between about 25 ppm and about 75 ppm; and

one or more additives; and

applying a plating bias between the substrate and an anode positioned in an anolyte chamber of the plating cell, the anolyte chamber being separated from the catholyte chamber by an ionic membrane, wherein the difference between the catholyte solution and the anolyte solution is that the catholyte solution comprises the one or more additives.

26. (Original) The method of claim 25, wherein the anolyte comprises a copper source having a concentration of greater than about 51 g/L.

27. (Original) The method of claim 26, wherein the anolyte has a pH of between about 2 and about 4.8.

28. (Original) The method of claim 26, wherein the ionic membrane comprises a membrane having a polydivinylbenzol matrix.

29. (Previously Presented) A method for plating metal onto a substrate, comprising:

positioning the substrate in a catholyte solution contained in a catholyte chamber of a plating cell, the catholyte solution comprising a copper source at a concentration of between about 0.8M and about 0.9M and one or more additives; and

applying a plating bias between the substrate and an anode positioned in an anolyte chamber of the plating cell, the anolyte chamber being separated from the catholyte chamber by an ionic membrane and being supplied with an anolyte solution comprising a copper source at a concentration of greater than about 51 g/L, wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode.

30. (Previously Presented) The method of claim 29, wherein the ionic membrane comprises a membrane having a polydivinylbenzol matrix.

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31. (Previously Presented) The method of claim 29, wherein the upper surface of the anode is tilted between about 3° and about 30° from horizontal.